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"Signalling in a Telecommunications System"
(Signallointi telekommunikaatiojärjestelmässä)

Hakemus on hakemusdiaariin 26.11.98 tehdyn merkinnän mukaan siirtynyt TELEFONAKTIEBOLAGET L M ERICSSON nimiselle yhtiölle, Stockholm, Sweden.

The application has according to an entry made in the register of patent applications on 26.11.98 been assigned to TELEFONAKTIEBOLAGET L M ERICSSON, Stockholm, Sweden.

Täten todistetaan, että oheiset asiakirjat ovat tarkkoja jäljennöksiä patentti- ja rekisterihallitukselle alkuaan annetuista selityksestä, patenttivaatimuksista, tiivistelmästä ja piirustuksista.

This is to certify that the annexed documents are true copies of the description, claims, abstract and drawings originally filed with the Finnish Patent Office.

Pirjo Kaila
Tutkimussihteeri

Maksu 300,- mk
Fee 300,- FIM

Osoite: Arkadiankatu 6 A
Address: P.O.Box 1160
FIN-00101 Helsinki, FINLAND
Puhelin: 09 6939 500
Telephone: + 358 9 6939 500
Telefax: 09 6939 5204
Telefax: + 358 9 6939 5204

Signalling in a Telecommunications System

Field of the Invention

The present invention relates to signalling in a telecommunications system and in particular, though not necessarily, to the transmission of signalling data associated with voice or data calls.

Background to the Invention

In a telecommunications system, signalling equipment and signalling channels are required for the exchange of information between system elements or nodes. In particular, this internode signalling informs the nodes of what is to be performed when a telephone or data call is to be set up or released in so-called "circuit-switched" connections. Modern telecommunications systems now largely make use of Common Channel Signalling (CCS) whereby signalling information is transmitted on one or more dedicated signalling channels, distinct from the channels used to carry actual user information (e.g. voice or data). An important feature of CCS is that the same signalling system may support services in a variety of existing telecommunications protocols, e.g. Public Switched Telephone Network (PSTN), Integrated Services Digital Network (ISDN), and Public Land Mobile Networks (PLMN), as well as proposed future protocols such as B-ISDN, enhancing greatly the interoperability of networks supporting different protocols.

Currently, the predominant CCS is known as Signalling System Number 7 (SS7), defined in the ITU-T (International Telecommunications Union - Technical) recommendations starting with Q.700. SS7 is a packet switched system occupying one time slot per frame of the

Time Division Multiple Access (TDMA) E.1 or T.1 transmission formats (the other time slots being available for user data). Individual signalling message packets (datagrams) are associated with respective individual telephone calls. As only a relatively small amount of signalling information is associated with a single telephone call, a single SS7 channel is able to handle all signalling between two network nodes (termed "signalling points") for several thousands of calls. It is noted that the route taken by a signalling message in the SS7 network may be the same as that over which the associated telephone call is established, or it may be different.

As already noted, SS7 (along with other CCS systems) is able to support a number of different telecommunications protocols (e.g. PSTN, ISDN, PLMN). In signal processing terms, SS7 comprises a Message Transfer Part (MTP) which deals with the physical transfer of signalling information over the signalling network, i.e. message formatting, error detection and correction, etc, and user parts and application parts which allow several "users" (i.e. ISDN User Part, Telephony User Part, etc) to send signals in the same signalling network.

SS7 makes use of addresses known as Point Codes to route signalling data through the "visibility area" of a telecommunications network, the visibility area typically being the network itself together with the interfaces between the network and "foreign" networks under the control of other operators. A Point Code is placed in the header of a signalling packet and is examined by a network signalling point (SP) upon receipt of the packet to determine the next hop for the packet *en route* to its destination.

In an SS7 network, any change in the Point Code allocation within the visibility area requires the operator to update the Point Code database (or routing table) which exists in each SP of the network. This however adds significantly to the maintenance overheads of the network. The dedicated nature of SS7 makes it in general expensive to install and maintain (in relation to both hardware and software), a significant barrier especially to prospective new telecom operators. Furthermore, as an SS7 network occupies bandwidth on TDMA frames of the E.1/T.1 transmission protocols (one slot per time frame), the bandwidth available for actual user call data is restricted. Yet another disadvantage of traditional signalling architectures is that the interoperability of SS7 networks is limited due to the dedicated nature of the MTP physical layers.

Summary of the Present Invention

It is an object of the present invention to overcome or at least mitigate the above noted disadvantages of existing telecommunication signalling systems.

According to a first aspect of the present invention there is provided apparatus for transmitting signalling data between signalling transfer points, signalling points, or a combination of both, in an SS7 signalling network, the apparatus comprising:

a first SS7/IP gateway device coupled to a first signalling point or signalling transfer point and also to an Internet Protocol (IP) network; and

a second SS7/IP gateway device coupled to a second signalling point or signalling transfer point and also to said IP network,

wherein the first and second SS7/IP gateway devices are arranged to receive SS7 signalling data from said signalling points or signalling transfer points coupled

thereto and to convert that data into a format suitable for transmission over the IP network and to perform a reverse conversion for signalling data received from the IP network.

In certain embodiments of the present invention, the gateway devices of the apparatus are standalone devices. In other embodiments however, the gateway devices may be integrated into a signalling point or signalling transfer point.

The gateway nodes may be coupled to the IP network via respective Internet Access Servers. Alternatively, the gateway nodes may be coupled directly to the IP network.

Preferably, the gateway nodes are coupled to respective signalling points/signalling transfer points via PCM or TDMA links, e.g. E.1 (2Mb/s, 32 channels) or T.1 (1.5Mb/s, 24 channels).

Preferably, the gateway nodes are coupled to respective IASs via packet switched data links, e.g. using ethernet or ATM.

The gateway devices may be provided with conversion means for converting between the ISUP messaging format and the SIP messaging format; between an H.323 messaging format and the SS7 call set-up format, between ISUP and a network access server control protocol, e.g. etheric; or between ISUP and a voice-over-IP control protocol, e.g. Q.767++.

The gateway devices may be provided with an interface for tunnelling SS7 application part messages over IP. For example, the gateway devices may each have one of the following protocol stacks arranged on the SS7 and IP sides:

SS7 side	IP side
ISUP/MTP	ISUP/IP
MAP/TCAP/MTP	MAP/TCAP/IP
INAP/TCAP/MTP	INAP/TCAP/IP

The gateway nodes may be arranged to determine the IP routing address for a received message or series of messages from one or more of the Signalling Link Selection + Service Information Octet, Subsystem number, and Global Title Translation.

Embodiments of the present invention enable the separation of information for transmission through the system into call information and signalling information. The use of the IP based network for transmitting signalling information releases capacity in the originating system for use by call information. In addition, the use of the IP network reduces the need for conventional signalling infrastructure (although this may still be used in part). IP based networks offer increased flexibility (e.g. routers of the network have self-updating routing tables) and reduced operating, maintaining, and engineering costs in comparison with conventional telecommunications signalling networks.

Preferably, the signalling data transmitted through the IP network comprises signalling information associated with call set-up and call termination in the first transmission network of the telecommunications system. Signalling information relating to call charging may also be transmitted through the IP network.

According to a second aspect of the present invention there is provided a method of sending signalling information between signalling points and/or signalling transfer points of a telecommunications network, the method comprising:

sending SS7 signalling data from a first signalling point/signalling transfer point to a first SS7/IP gateway;

formatting the signalling data at the first gateway into a format suitable for transmission over an IP network;

transmitting the formatted data from the first gateway to a second SS7/IP gateway over an IP network;

receiving the formatted data at the second gateway and recovering therefrom the original signalling data; and

sending the recovered signalling data to a second signalling point/signalling transfer point.

According to a third aspect of the present invention there is provided a method of communicating voice and other user information between a pair of end users, a first of the end users having a circuit switched connection to a telecommunications network and the second of the end users having a packet switched connection to an IP network, the method comprising exchanging signalling information between the telecommunications network and the IP network via a gateway device arranged to convert the signalling data between a voice-over-IP format and an SS7 format.

Brief Description of the Drawings

For a better understanding of the present invention and in order to show how the same may be carried into effect reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 illustrates schematically a telecommunications system comprising two interconnected telecommunications networks;

Figure 2 illustrates functionally the architecture of a gateway device of the system of Figure 1;

Figure 3 illustrates schematically the signal processing layers of the SS7 protocol;

Figure 4 illustrates the processing layers present at a gateway node of the system of Figure 1;

Figure 5 illustrates the flow of signalling data associated with call set up and termination in the system of Figure 1; and

Figure 6 is a flow diagram illustrating the signalling process employed in the system of Figure 1.

Detailed Description of Certain Embodiments

A telecommunications system in which the present invention may be employed typically comprises one or more interconnected telecommunications networks. These networks may make use of the same telecommunications protocols (e.g. ISDN, PSTN, PLMN) or may use different protocols. In addition, the networks may be operated by the same or by different operators. However, the networks have in common that they use Signalling System No.7 for communicating signalling information between internally located signalling points (SP).

Considering Figure 1, this illustrates a much simplified telecommunications system comprising only two telecommunications networks 1,2. Both of these networks 1,2 are assumed to be Integrated Digital Services Networks (ISDN). Each network comprises a number of switching exchanges 3 interconnected by trunk lines 4. In addition, a trunk line 5 provides a link between exchanges 3 of the two networks 1,2.

In order to connect a call, placed from a first subscriber telephone 6 (A-subscriber) to a second subscriber telephone 7 (B-subscriber) connected to local exchanges of the respective networks, it is necessary for the system to reserve a traffic channel between each

of the four illustrated exchanges 4, using the trunk lines 4,5. Each traffic channel is a circuit switched channel, i.e. comprising a reserved time slot in each consecutive transmission frame, and as such the network through which a call is routed is referred to here as a "circuit-switched network".

As already mentioned above, conventionally, the interexchange signalling required to set up the various circuit switched channels is conveyed by SS7. In the system of Figure 1, an SS7 network 8 is provided in each of the telecommunications networks 1,2. Each SS7 network 8 handles the flow of signalling information between signalling points (e.g. exchanges 3) of the associated network. Signalling information may be routed directly between two signalling end points, or it may be routed through intermediate Signalling Transfer Points (STP) 9. It will be appreciated that although the SS7 networks are illustrated in Figure 1 as being distinct from the circuit switched network, the SS7 networks may make use of the trunk lines 4 for transmitting signalling data, and that the STPs 9 may be associated with respective exchanges 3.

Each of the networks 1,2 comprises a gateway device 10 which provides an interface for the SS7 network 8 to an IP network 11. In Figure 1, the gateway devices 10 are coupled to the IP network 11 via respective Internet Access Servers 12, although it will be appreciated that this coupling may be achieved directly without intervening Internet Access Servers 12.

It is noted here that the term "IP network" is intended to include networks utilising the current *de facto* IP standard as defined by the Internet Engineering Taskforce or a future derivative thereof (including the TCP or UDP protocol layers). The network 11 may be a

closed network under the control of the telecommunications network operator(s), i.e. an intranet, or an open network accessible through the World Wide Web (i.e. the Internet). In either case, the substitution of the IP network for a significant part of the SS7 network provides a number of significant advantages, chiefly a reduction in the signalling traffic and processing required in the conventional telecommunications network and replacement of expensive, dedicated telecommunications infrastructure with low cost, flexible datacom infrastructure.

For each of the networks 1,2, the gateway device 10 is coupled on the one side to the Internet Access Server 12, and on the other side to STPs 9 of the SS7 network 8. Whilst the gateway device 10 may be connected to every STP 9 of the SS7 network 8, it is preferred that connection is made to only a subset of all STPs 9 of the SS7 network 8, such that signalling information to be transmitted between a give STP 9 and the gateway device 10 may require routing through one or more intermediate STPs 9. Figure 2 illustrates schematically a possible architecture for the gateway devices 12.

It will be appreciated that signalling information to be transmitted from a signalling point of one network 1,2, to a signalling point of the other network, through the TCP/IP network 11, requires protocol conversion at both of the gateway devices 10. More particularly, it is necessary to process signalling messages such that the physical message construction, and associated error detection and correction processes etc, are appropriate for the medium over which the message is next to be transmitted.

Figure 3 illustrates the seven layers (or levels) which compose the SS7 protocol. These layers will not be

described here in detail, but rather the reader should make reference to the ITU-T recommendations starting with Q.700. It is sufficient here to note that layers 1 to 3 provide the physical, datalink, and network layers, whilst layers 4 to 7 provide user parts and application parts which are generally network specific (in particular, the TCAP provides transaction capabilities for services such as INAP, MAP, OMAP, etc).

Figure 4 illustrates the processing layers which are provided at the gateway device 10 in order to provide for the conversion of signalling messages between the SS7 protocol and the TCP/IP protocol. On the SS7 network side of the interface, there is provided the MTP of the SS7 protocol, whilst on the TCP/IP side the MTP is replaced by TCP/IP protocol layers. Signalling messages received at the gateway device 10 from the SS7 network 8 are thus processed through the MTP to retrieve the signalling information originally generated within an SP of the SS7 network by a user part.

At the gateway device 10, this user part generated data is passed by the MTP to an intermediate processing layer (identified by reference numeral 12). This layer 12 adds to each signalling message a header (9bits) indicating the number of octets which the message contains. The processed messages are then passed to the TCP/IP protocol layers where they is organised for transmission over the TCP/IP network 11 via the IAS 12.

In the same way, when signalling data is received at a gateway device 10 from the IAS 12, the signalling information is processed through the TCP/IP layers to recover the user part generated data, with the signalling message length header being removed in the intermediate layer 12, before passing the data to the

MTP in preparation for transmission over the SS7 network 8.

It is noted that Figure 4 illustrates a user part(s) layer above the MTP and TCP/IP layers. However, this layer is not normally utilised in the gateway device unless the node is directly connected to a switching exchange 4 such that signalling information can be passed directly from the user parts (e.g. TUP, ISUP, etc) to the TCP/IP layers and *vice versa*.

It will also be appreciated that whilst signalling messages are routed in the SS7 network using SS7 Point Codes, messages in the IP network are routed using IP addresses. Gateway devices may therefore be provided with a database mapping point codes to IP addresses, using dynamic updating if necessary.

Figure 5 illustrates the flow of signalling information associated with set up and termination of a call between the two telephones 6,7 of Figure 1, where the signalling points are identified using the same symbols as are used in Figure 1. Figure 6 is a flow diagram illustrating the signalling process described above.

It will be appreciated by the person of skill in the art that modifications may be made to the above described embodiments without departing from the scope of the present invention. For example, whilst the user voice or data channel has been described above as being a circuit switched channel (E.1/T.1), this channel may be provided, in whole or in part, by a packet switched channel, e.g. where the call is made from or to a mobile telephone registered with a mobile network utilising the proposed General Packet Radio Service (GSM phase 2+).

Claims

1. Apparatus for transmitting signalling data between signalling transfer points, signalling points, or a combination of both, in an SS7 signalling network, the apparatus comprising:

a first SS7/IP gateway device coupled to a first signalling point or signalling transfer point and also to an Internet Protocol (IP) network; and

a second SS7/IP gateway device coupled to a second signalling point or signalling transfer point and also to said IP network,

wherein the first and second SS7/IP gateway devices are arranged to receive SS7 signalling data from said signalling points or signalling transfer points coupled thereto and to convert that data into a format suitable for transmission over the IP network and to perform a reverse conversion for signalling data received from the IP network.

2. Apparatus according to claim 1, wherein the gateway devices are standalone devices.

3. Apparatus according to claim 1 or 2, wherein the gateway devices are integrated into respective signalling points or signalling transfer points.

4. Apparatus according to any one of the preceding claims, wherein the gateway nodes are coupled to the IP network via respective Internet Access Servers.

5. Apparatus according to claim 4, wherein the gateway nodes are coupled to respective IASs via packet switched data links.

6. Apparatus according to any one of the preceding claims, wherein the gateway nodes are coupled to respective signalling points/signalling transfer points via PCM or TDMA links.

7. Apparatus according to any one of the preceding claims, wherein the gateway devices are provided with conversion means for converting between: the ISUP messaging format and the SIP messaging format; an H.323 messaging format and the SS7 call set-up format; ISUP and a network access server control protocol; or between ISUP and a voice-over-IP control protocol.

8. Apparatus according to any one of the preceding claims, wherein the gateway devices may be provided with an interface for tunnelling SS7 application part messages over IP.

9. Apparatus according to any one of the preceding claims, wherein the gateway nodes are arranged to determine the IP routing address for a received message or series of messages from one or more of: the Signalling Link Selection + Service Information Octet; Subsystem number; and Global Title Translation.

10. A method of sending signalling information between signalling points and/or signalling transfer points of a telecommunications network, the method comprising:

sending SS7 signalling data from a first signalling point/signalling transfer point to a first SS7/IP gateway;

formatting the signalling data at the first gateway into a format suitable for transmission over an IP network;

transmitting the formatted data from the first gateway to a second SS7/IP gateway over an IP network;

receiving the formatted data at the second gateway and recovering therefrom the original signalling data; and

sending the recovered signalling data to a second signalling point/signalling transfer point.

11. A method of communicating voice and other user information between a pair of end users, a first of the end users having a circuit switched connection to a telecommunications network and the second of the end users having a packet switched connection to an IP network, the method comprising exchanging signalling information between the telecommunications network and the IP network via a gateway device arranged to convert the signalling data between a voice-over-IP format and an SS7 format.

Abstract (57)

A method of transmitting signalling information between signalling points (3,9) of a telecommunications system, the signalling information being associated with a subscriber-to-subscriber (6,7) voice or data traffic channel carried by a circuit switched channel transmission network (1,2). The method comprises transmitting signalling information between said signalling points (3,9) via a TCP/IP network (11) which is separate from the circuit switched channel transmission network.

Fig. 1

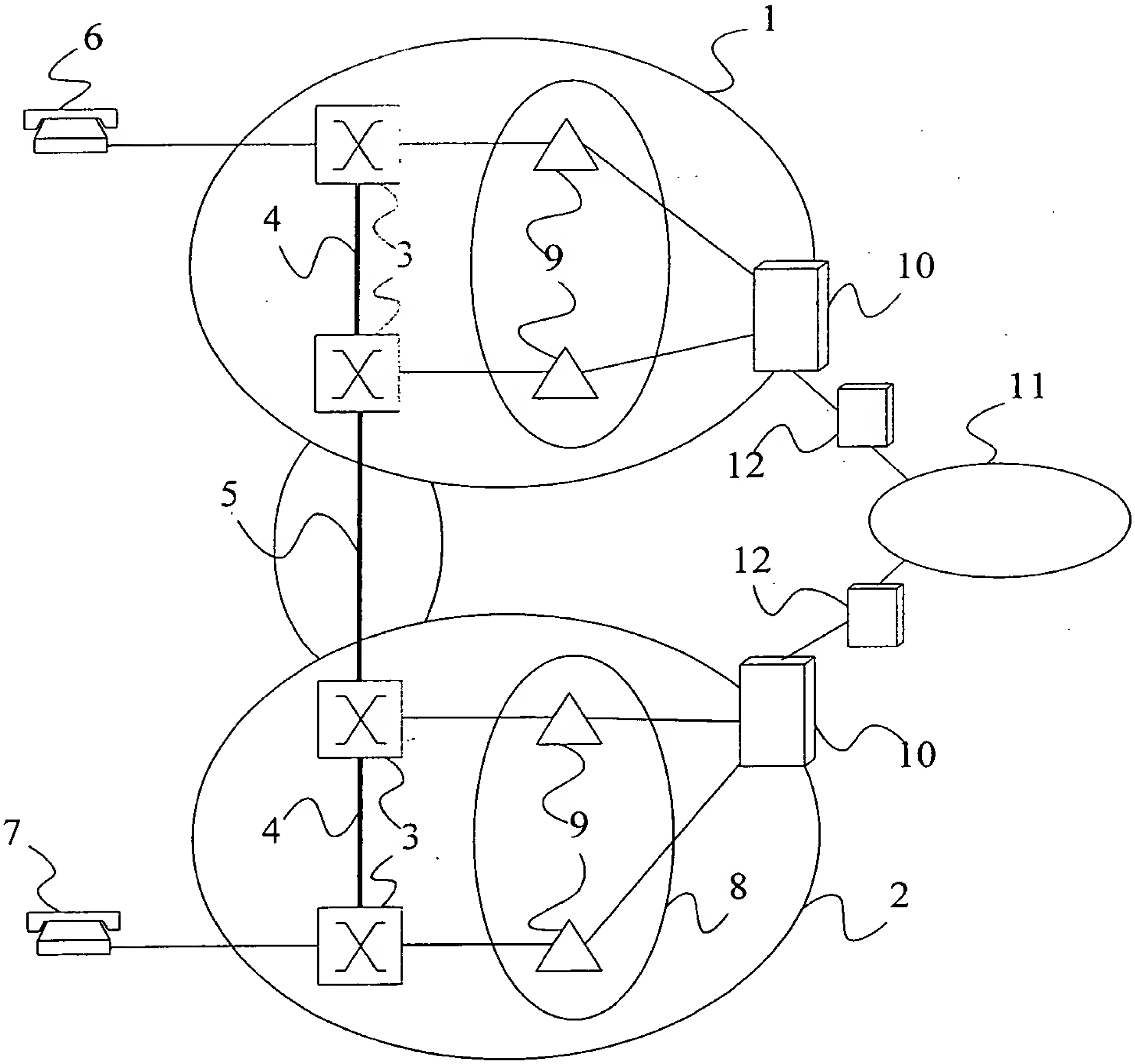

Figure 1

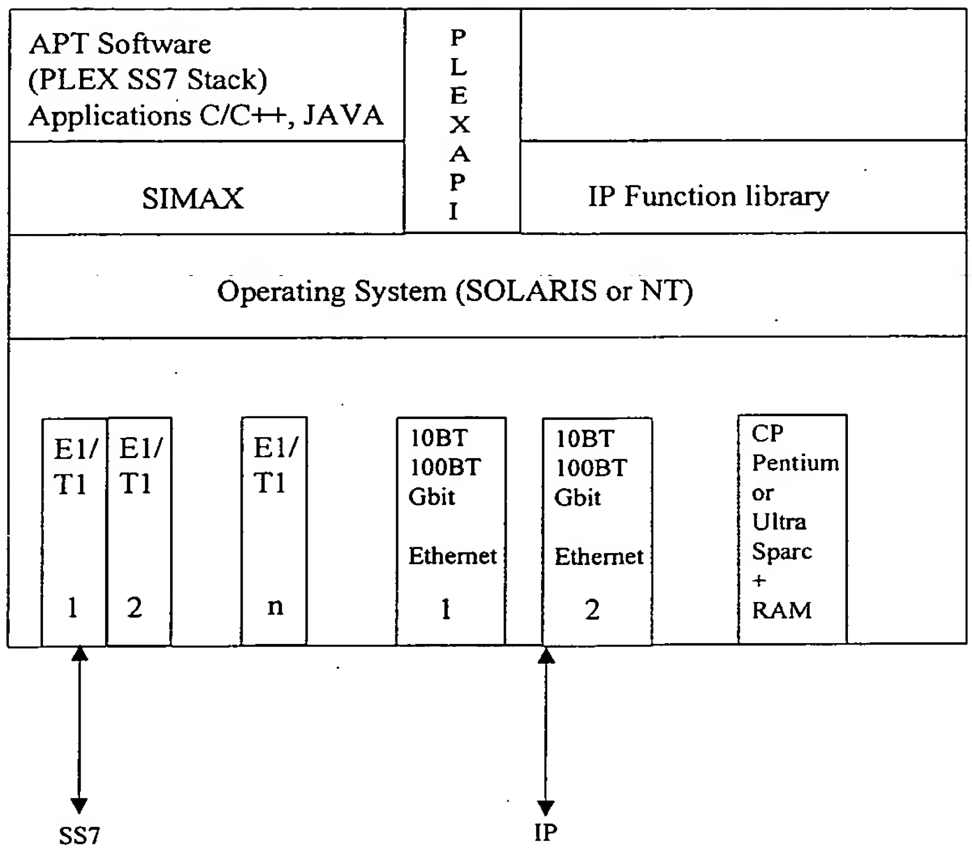
APT Software
(PLEX SS7 Stack)
Applications C/C++, JAVA
PLEXAPI
SIMAX
IP Function library
Operating System (SOLARIS or NT)
E1/T1 1
E1/T1 2
E1/T1 n
10BT 100BT Gbit Ethernet 1
10BT 100BT Gbit Ethernet 2
CP Pentium or Ultra Sparc + RAM
SS7
IP

Figure 2

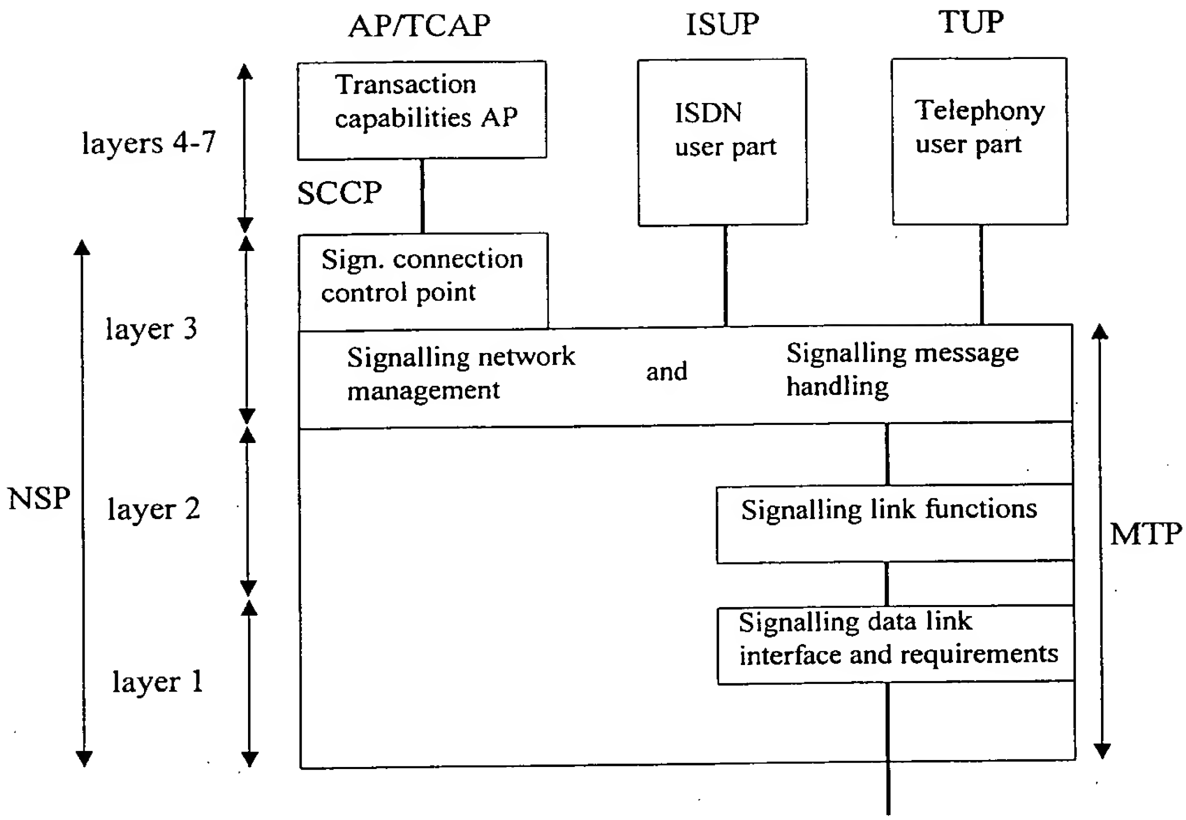

Figure 3

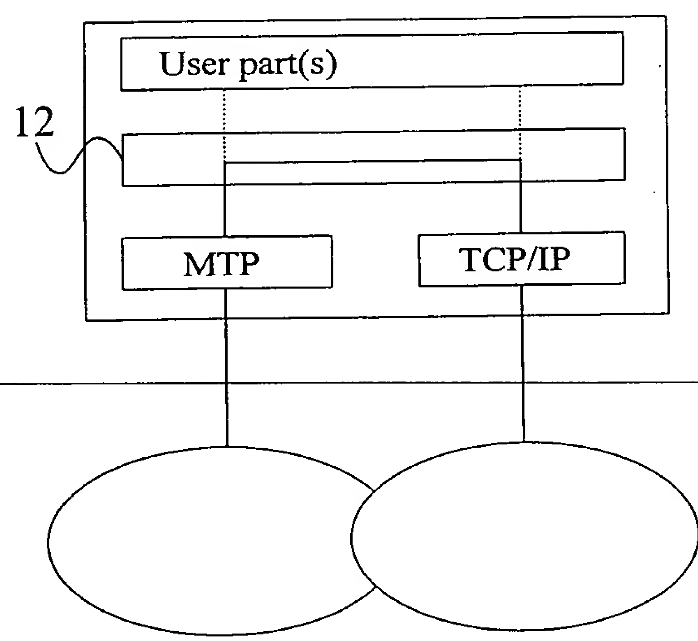

Figure 4

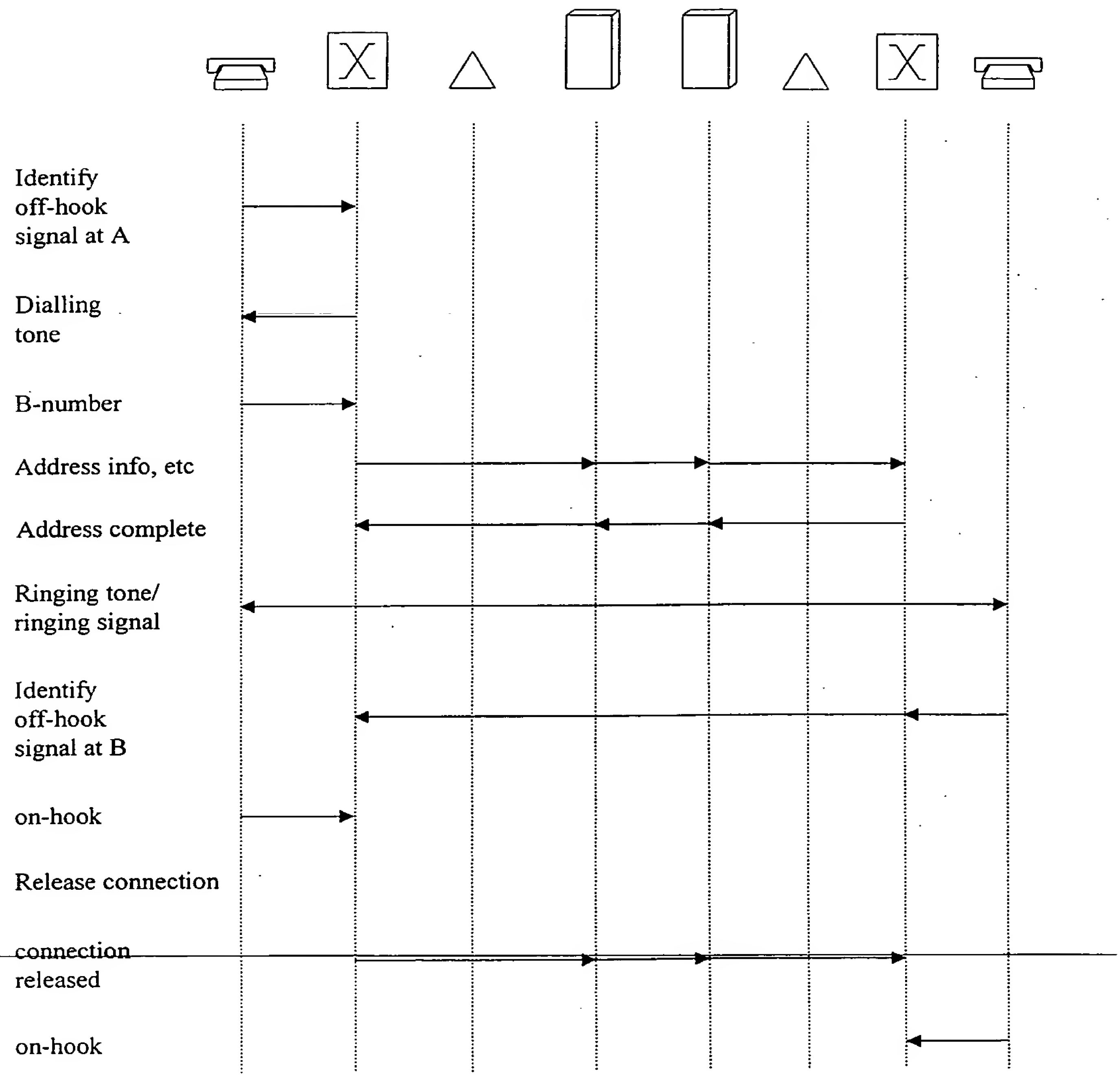
Identify
off-hook
signal at A
Dialling
tone
B-number
Address info, etc
Address complete
Ringing tone/
ringing signal
Identify
off-hook
signal at B
on-hook
Release connection
connection
released
on-hook

Figure 5

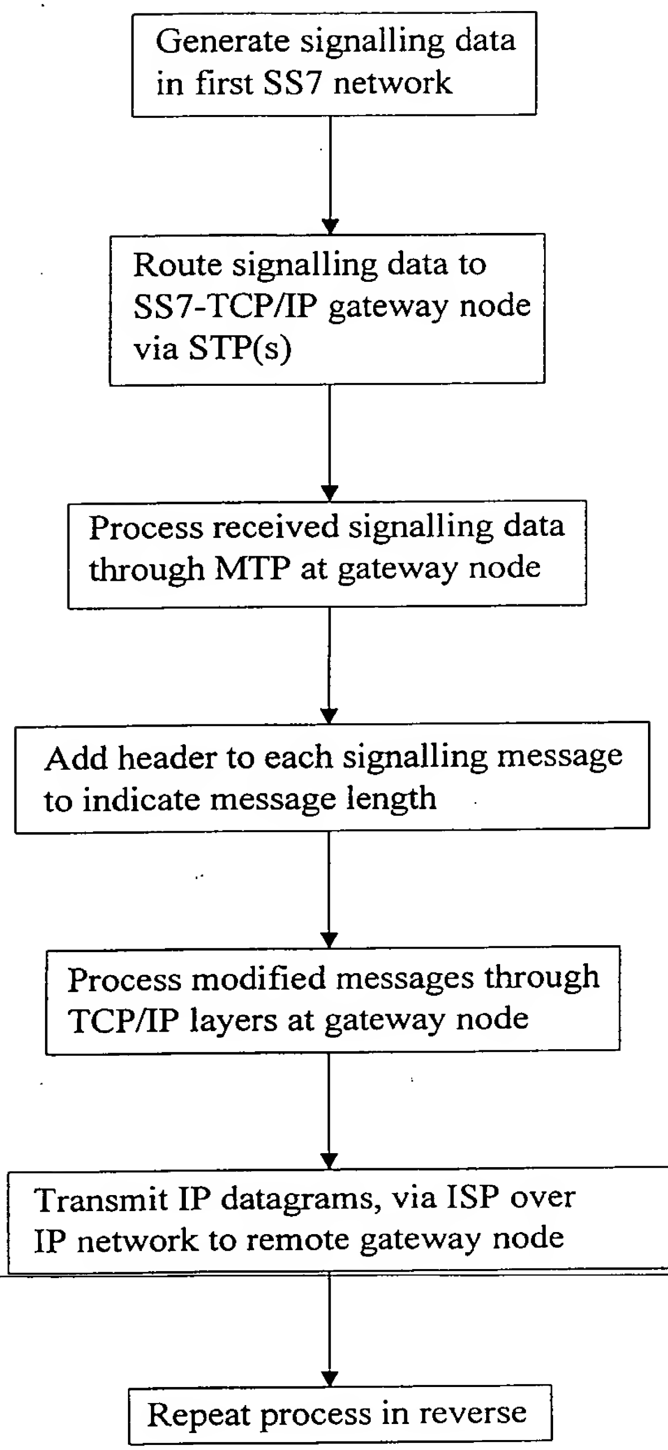
Generate signalling data in first SS7 network
Route signalling data to SS7-TCP/IP gateway node via STP(s)
Process received signalling data through MTP at gateway node
Add header to each signalling message to indicate message length
Process modified messages through TCP/IP layers at gateway node
Transmit IP datagrams, via ISP over IP network to remote gateway node
Repeat process in reverse

Figure 6